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## **Increasing Coastal Resiliency Through Intermunicipal Shoreline Management**

Phase 1 Final Report Prepared for the Towns of Eastham,  
Wellfleet, Truro, and Provincetown

A report prepared for the Town of Wellfleet  
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## Foreword

*Increasing Coastal Resiliency Through Intermunicipal Shoreline Management*, a grant project pursued in conjunction with the towns of Eastham, Wellfleet, Truro, and Provincetown and the Massachusetts Office of Coastal Zone Management (CZM), is perhaps one of the first efforts in the Commonwealth to implement a program of regional shoreline management based on the proven successes of what have been traditionally, uniquely local responses. The impetus for the project began in 2017 with ongoing discussions between the project team, consisting of Hillary Lemos (Wellfleet), Shana Brogan (Eastham), Emily Beebe (Truro), Tim Famulare and Rex McKinsey (Provincetown), Steve McKenna (CZM) and the Center For Coastal Studies (CCS). Recognizing that the characteristics contributing to the resiliency and ability of shorelines to respond naturally to coastal hazards operate independently of municipal boundaries, discussions began to focus on the potential for a regional approach to shoreline management. Recognizing that the record is replete with examples where coastal resiliency is reduced unintentionally because of contrasting or conflicting management approaches by neighboring communities, project team discussions focused on ways to facilitate and promote consistent, synergistic, and uniform management techniques that treated the Cape Cod Bay shorelines of their four communities as one planning area.

As shown on Figure 1, the boundary of the planning area consists of approximately 128 miles<sup>2</sup> of Cape Cod Bay and approximately 46 miles of Bay facing shoreline. Eliminating municipal boundaries, the area extends generally from the Eastham town line in Rock Harbor to Race Point in Provincetown. The inland boundary was based largely on the following coastal wetland resource areas as defined in the Massachusetts Wetlands Protection regulations (310 CMR 10.00) and mapped by the MA Department of Environmental Protection (DEP) in 2005: coastal bank; coastal dune; coastal beach; barrier beach; tidal flats; and salt marsh. Several discrete sections of the inland boundary required using a 100-meter buffer to the 2005 DEP mapping to account for erosion and a landward migration of resource areas. The seaward limit extends to the state-municipal boundary as set forth in M.G.L. 42, s.1 and depicted by MassGIS.

Characterized by a continuous shoreline and low lying areas, the planning area experiences similar effects related to climate change directly in the form of frequent powerful coastal storms with high storm surges, significant flooding of public and private roadways and structures, increased frequency in damage to upland infrastructure as a result of tidal flooding, and overburdened stormwater management systems.

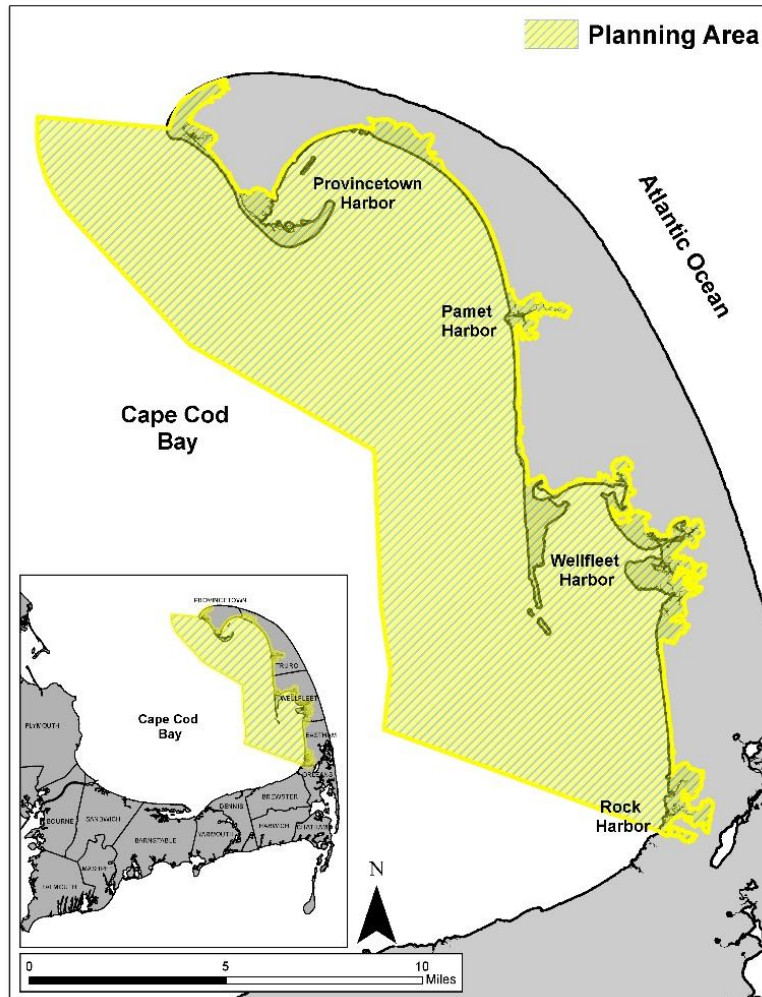


Figure 1: Planning Area

In response to these emerging threats and to increase coastal resiliency throughout the planning area, the four towns have begun a process to implement a comprehensive, regional approach for managing their bay shorelines in a way that will provide the following long-term benefits:

- More effective responses that are based on increasingly uniform, proactive regional management of shoreline resources and less on traditional, localized reactive regulation of individual shoreline activities
- More effective and comprehensive public process
- Improved cost efficiencies & savings with common municipal goals and objectives in terms of:
  - Economies of scale
  - Intermunicipal design and construction projects
  - Public & private project cost sharing – e.g., nourishment
- Greater leveraging of grant opportunities

- Increased resiliency in shoreline infrastructure/protection and more effective project review & oversight
  - Uniform performance standards
  - Common design requirements
  - Standardized project conditions

As described in the Methods section of this report, the initial phase of this project focused on the development of base line conditions that include: 1) a comprehensive geodatabase of human uses and alterations (e.g. structures, dredging, replenishment, etc.), natural resources and a characterization of shoreline resilience, (e.g. rates of shoreline change, inundation vulnerability, sediment transport pathways and obstructions such as groins, harbors, etc.); 2) the identification of the existing regulatory structure including a comparison of local by-laws and traditional management approaches of each town; 3) assessment of the strengths and weakness of the individual approaches to shoreline management, including consistencies and inconsistencies; and 4) the identification of some challenges to implementing a natural, system-based management approach within the context of a traditional intermunicipal management framework.

Recognized as Phase 1 of a longer-term effort, this report provides findings summarizing the similarities and differences in the natural and human environments in town management approaches in the planning area and recommendations for necessary work of future phases. Perhaps most significantly the project produced a signed Intermunicipal Memorandum of Agreement (MOA) memorializing each town's commitment to continue to pursue the implementation of a mutually beneficial regional management approach for their Cape Cod Bay shorelines in subsequent phases.

## **Overview**

With a long-term goal of implementing a regional shoreline management framework for the eastern shoreline of Cape Cod Bay, a significant component of this project focuses on identifying existing baseline conditions that influence current municipal responses to shoreline management opportunities and challenges. Information used to characterize baseline conditions focused generally on the compilation, distillation and comparison of similarities and differences in relevant coastal resources, human uses, and regulatory practices in the planning area. Available and newly created data sets of coastal resources and human uses were incorporated into a comprehensive geodatabase developed for the project to facilitate interactive querying and spatial analysis. Similarly, management information obtained from town bylaws, regulations, policies, and listening sessions with town staff was used, to develop data sets that were incorporated into the geodatabase to provide a spatial component to comparisons of baseline shoreline management considerations. To assist with communicating complex scientific information, working with the five project team members (four conservation agents and Provincetown's Marine Coordinator) new theme-based geospatial data sets were also developed and incorporated into the geodatabase.

Concluding Phase 1, geospatial data and information describing the existing shoreline management framework for the planning area were incorporated into an Intermunicipal Shoreline Management Geodatabase to inform initial recommendations for the development and implementation of a regional approach to the management of the eastern Cape Cod Bay shores in subsequent phases. Significantly, the goals and recommendations of Phase 1 were supported and memorialized in a MOA, endorsed unanimously by the Select Boards of Eastham, Wellfleet, Truro, and Provincetown, agreeing to continue to pursue regional shoreline management.

The following sections describe the process of developing these recommendations and the MOA in more detail. The full text of the MOA can be seen in Appendix A.

## **Shoreline Resource Database**

To begin the development of the intermunicipal shoreline management framework, an up-to-date database of contemporary shoreline characteristics of the planning area was compiled from available sources in shapefile, raster, and table formats with supplemental hard copy documents. Generally, data describing baseline conditions were organized into the following broad categories:

- Inventory of Human Uses and Alterations
- Catalogue of Coastal Resources
- Characterization of Shoreline Resilience

### *Inventory of Human Uses and Alterations*

With the exception of 10 miles of Cape Cod National Seashore (CCNS) shoreline, the majority of the eastern shoreline of Cape Cod Bay in the planning area is characterized by large stretches of single family residences located along private beaches interspersed with business and commercial development in concentrated areas of Eastham, Wellfleet, Truro, and Provincetown. To better characterize the nature of existing development within the planning area, Assessors records from each town were combined to produce a comprehensive record of parcel level information. Since the geospatial components of these records were developed individually by each municipality, parcel lines along municipal boundaries often did not align requiring additional research and evaluation. Once line inconsistencies, gaps, and gores were resolved to the maximum extent possible a subset from the larger town-wide assessor's data was created to characterize parcel level information within the planning area.

In addition to parcel level assessor's information, zoning information from each town was compiled in the database to further describe human interaction with the shoreline in the planning area. Among other things, these data can be used to characterize primary land uses and minimum lot sizes associated with current and potential development.

Extensive lengths of the planning area shoreline are presently armored with various types of seawalls. These structures, both public and private, were characterized in two projects overseen by the Massachusetts Department of Conservation and Recreation (DCR) and the Massachusetts Office of Coastal Zone Management (CZM) in several reports and updates. A Coastal Infrastructure Inventory and Assessment Pilot Project of public structures extending from Plymouth to Hull was completed in 2009 with the inventory extended to the remainder of coastal communities shortly thereafter (Bourne Consulting, 2009). A similar inventory of private structures was completed in 2013 using remote sensing techniques (AAA, 2013). These inventories were updated for the planning area by Applied Coastal Research and Engineering (the same firm who completed the 2009 inventory for Eastham, Wellfleet, Truro, and Provincetown) using project records furnished by the towns, contemporary aerial imagery, and, where appropriate, site visits. The results of this inventory were incorporated into the Shoreline Resource Database.

Since nourishment is required by Wellfleet and Eastham as mitigation for shoreline armoring projects and by Truro with the approval of drift fence projects, detailed information from records provided by each town was compiled and organized within the resource database. As a significant source of beach nourishment material, annual dredging volumes associated with Pamet Harbor were also reflected in the database. Where available, this information included the location of beach replenishment activities, placement methods and volumes, sediment sources, funding sources (public or private) and purpose (annual mitigation, as needed for storm response, public landing maintenance etc.). Given the highly developed nature of the Provincetown shoreline,



annual nourishment is not a set requirement for waterfront owners with nourishment typically placed along general shoreline areas as needed. These additional nourishment volumes, not available for Phase 1, will be added to the database in Phase 2. With the addition of the Provincetown information, these data will provide up-to-date annual nourishment requirements for each waterfront parcel in the planning area

Recognizing the importance of annual nourishment to the resilience of many armored Cape Cod Bay shorelines, research of upland sand sources was begun to create an inventory of existing sand and gravel operations. As part of this effort an initial working data layer was created from available soils information published by the Natural Resources Conservation Service (NRCS) as part of its Barnstable County Soils Survey. This layer was not included in the geodatabase, however, as additional work is necessary to develop meaningful metrics concerning the ability of existing facilities to meet the demand for future nourishment material.

Recognizing that each town also maintains a harbor serving recreational and commercial interests, an extensive dataset documenting historical dredging activity was also compiled. Lacking a single archive of dredging records, CCS compiled information from a number of sources including: U.S. Army Corps of Engineers 404 permits; U.S. Army Corps of Engineers federal navigation project plans for Wellfleet and Provincetown Harbors; DEP Waterways Chapter 91 Licenses and plans; MEPA Environmental Notification (ENF) and Environmental Impact Report (EIR) submittals, Barnstable County Dredge Department records and invoices, and individual reports supplementing permit applications and town design efforts. Where possible the following information was compiled: dredging dates, dredge volumes, design plans, sediment type, time of year restrictions, funding mechanisms, purpose, dredge contractor, removal method, and sediment disposal sites. The compiled dataset and dredge plans were incorporated into the project GIS where possible and represent one of the more comprehensive sets of dredging information for the outer Cape harbors. These data will be instrumental in demonstrating the connectivity of these areas with one another for local managers and the public.

### *Catalogue of Coastal Resources*

To complement spatial data describing the human influence on the Bay shoreline, a catalogue of coastal resources and landforms describing the biological and geomorphological setting was also compiled. Since these features contribute to the storm damage prevention and flood protection characteristics of a naturally resilient shoreline, geospatial data was compiled from existing data sources such as MassGIS, CZM's MORIS, NOAA's Coastal Services Center, and the U.S. Geological Survey (USGS). These data were supplemented with contemporary aerial photography and LiDAR, and later incorporated into the Intermunicipal Shoreline Management Geodatabase. It takes a considerable amount of time to research the many online data download platforms for relevant data to be incorporated into any database. Similar datasets exist in many locations, representing different timeframes. Datasets must be sorted, metadata thoroughly read, and

redundant datasets removed. Typically, topology rules, rules that define spatial relationships between feature classes, would be incorporated into a geodatabase. Data layers, representing features from different dates and from different sources, depict features and feature boundaries differently. Features and feature definitions do not always align between datasets. Due to the number of sources used in the initial compilation the decision was made to not include topology rules into the geodatabase at this time. Instead of defining relationships and altering the original publicly available data, these data layers were simply organized in the geodatabase unmodified. For incorporation into the organizational structure of the geodatabase, some geographic transformations and projections were necessary.

The coastal resource data include information related to shellfish management areas, floodplains, areas of endangered species, and contemporary bathymetry and topography within the planning area. When displayed together, they highlight the seamless and generally similar geologic and biological conditions encountered throughout the planning area. Further, when municipal boundaries are removed, the associated picture of the planning area provides a uniform base map that can be used to promote and undertake an intermunicipal shoreline management approach for the 46-mile long shoreline stretching over 4 communities.

Recognizing that the provisions of the Massachusetts Wetlands Protection Act and the Wetlands regulations (310 CMR 10.00) apply uniformly to all municipalities, DEP's 2005 wetlands data layer was downloaded from MassGIS to serve as the base resource layer for the planning area. The boundaries of the planning area were based on the extents of the following coastal resource areas: Land under the Ocean (10.25); Coastal Beaches (10.27); Coastal Dunes (10.28); Barrier Beaches (10.29); Coastal Banks (10.30); and Salt Marshes (10.32). Detailed definitions of these resource areas are found in 301 CMR 10.04 and in corresponding sections of Additional Regulations for Coastal Wetlands (310 CMR 10.21-10.37).

Not surprisingly, unlike the boundaries of inland wetlands, the boundaries of coastal wetland areas are highly dynamic. This observation was particularly evident when the 2005 DEP wetlands shapefiles were overlaid on the MassGIS 2014 orthophotos. Careful inspection of the wetlands data layer revealed several areas where high rates of erosion illustrated where resource areas had migrated landward. For these discrete cases, the planning area boundary was modified using a 50-meter buffer of the highest high tide line extracted from the 2014 lidar. While not an issue for creating static boundaries for artificial features such as the planning area, the rapid obsolescence of mapped shoreline features such as coastal wetlands does highlight one of the challenges facing geospatial data specialists in terms of effectively visualizing and communicating information about the coastal environment.

### *Characterization of Shoreline Resilience*

A key focus of the Shoreline Resource -Database is the development of geospatial data that is current, easily retrievable, and communicates science-based findings accurately and simply to a management constituency of varied background. With this as an objective, using compiled human use and coastal resource information and the results of contemporary scientific research, geospatial data layers were developed to describe and assess contemporary shoreline resilience conditions within the planning area that represent common management challenges for each town. These layers were based on existing data provided by:

- CZM's Historical Shoreline Change projects.
- Recent projects completed by CCS with CZM grant funds to work with the National Weather Service to map Provincetown and Truro storm tide pathways for integration into the NWS Coastal Inundation web page.
- An ongoing project with the Barnstable County Extension Service and the National Weather Service to map storm tide pathways for the remainder of Cape Cod Bay shorelines information and integrate the data into the NWS Coastal Inundation web page.
- Completed CZM grant projects using historical data to assess and quantify century-scale Cape Cod Bay sediment budgets and transport pathways; and
- Using sediment transport system information to refine existing Cape Cod Bay littoral cell mapping as a prelude to defining coastal processes-based management units.

The geospatial data layers developed to characterize resilience form the basis for identifying future data development and mapping needs associated with the implementation of Phase 2 recommendations.

To depict the existing management framework, existing federal, state, and local regulations influencing the management of the Bay shoreline were compiled and used to assess possibilities for developing a common approach to increase coastal resiliency. Where possible, shapefiles were created to depict the geographic scope of each regulation and incorporated into the geodatabase to identify areas of duplication, overlap, and potential conflicts. Taking advantage of the flexibility of the geodatabase, additional layers will be added as appropriate in Phase 2 to keep information current.

### *Results and Recommendations*

The development of a comprehensive database consisting of quality geospatial data that describes the natural and human synergies and tensions found along the shoreline has been viewed as a fundamental component for the design of a science-based approach to regional shoreline management for the Cape Cod Bay shorelines of Eastham, Wellfleet, Truro, and Provincetown.

While Phase 1 focused primarily on evaluating, compiling, and integrating existing data sets into one shoreline resource database, it also began the process of developing datasets in ways that could communicate the scientific results of shoreline studies.

Recognizing that to be effective, a proactive management approach requires a clear understanding of local and regional coastal processes, resources, and systems, a clear goal of Phase 2 will focus on the continued analysis and communication of spatial information through the development of data layers that are responsive to the articulated needs of town resource management, emergency response, and public works departments.

Based on the project team discussions and feedback obtained from an additional targeted webinar presentation of the geodatabase to town staff not anticipated in the project scope of work, the following list summarizes suggestions for additional data layers that would help frame future local shoreline management decisions regionally.

- Through additional further analysis, continue to develop new data layers in ways that communicate science-based management information clearly and effectively (e.g., net sediment transport and associated management units, areas of erosion and accretion with rates).
- Develop uniform and consistent methods of town recordkeeping to facilitate updates and archiving of information related to ongoing activities related to permit decisions, beach nourishment and dredging.
- Develop and integrate a public beach management data layer that contains information regarding public access and town landings, high water beach areas, parking lot sizes, usage numbers, etc. to estimate staff, maintenance, and budget requirements, and for developing financial metrics such as the value of public beaches, public access ways, public and commercial shellfish access, etc.
- Identify individual littoral characteristics and develop and delineate a system of potential management units for the Bay shoreline absent town boundaries.
- Using completed storm tide pathway work, identify and develop an inventory of vulnerable roadways and infrastructure and where possible, develop potential evacuation based on various coastal storm scenarios. This information could also be used to develop mitigation scenarios.
- Create a data layer that identifies current and potential future sources of nourishment materials (e.g. gravel pits), including estimates of maximum extraction volumes and identification of potential parcels where nourishment material could be stockpiled.
- Create a data layer of low lying, flood prone parcels for potential open space acquisition.
- Create a data layer of potential parcels that could accommodate salt marsh migration for potential open space acquisition.
- Create a data layer of aquaculture lease areas with associated shellfish management information, such as access points and landing locations.

- Create a data layer of archiving management decisions (e.g., Orders of Conditions, c.91 licenses, etc.)

## **Four Town Regulatory Matrix**

In addition to a comprehensive database characterizing the regulatory environment of the planning area, specific attention was focused on developing a matrix of local bylaws, regulations, policies, and guidance documents influencing contemporary shoreline management decisions along the Bay shoreline. The matrix was organized around the Wetlands Protection Act and the associated Wetlands regulations (310 CMR 10.00) since they apply consistently to each town and as resource-based regulations are implemented through uniform performance standards. Based on material provided by each town, key characteristics of local wetland by-laws, regulations, and policies, local zoning development requirements, and flood plain zoning, were identified, and added to the matrix to assess similarities and differences in current management approaches between towns and with state Wetland regulations.

From a coastal wetland perspective, areas of comparison included: sources of authority; regulatory purpose; interests and values protected; jurisdiction; and activities subject to regulation. Local floodplain zoning bylaw comparisons focused on: review authority; floodplain boundaries; bylaw purpose; use regulations; and allowable uses. Finally, local zoning comparisons sought to characterize the shoreline in terms of allowable uses and development densities, including primary uses; and dimensional requirements such as minimum lot areas, lot line setbacks, and maximum heights. A copy of the detailed regulatory matrix is included in Appendix B.

### *Results and Recommendations*

In 2013, the Environmental Law Institute (ELI), noted that the Massachusetts Wetlands Protection Act (M.G.L. c.131, s.40) serves as the primary tool for safeguarding both coastal and freshwater wetlands (Environmental Law Institute, 2016). This finding is supported by the comparison of local bylaws and regulations and the state wetland regulations presented in the regulatory matrix.

Activities proposed within the jurisdiction of the Massachusetts Wetlands regulations must comply with performance standards designed to protect and promote not only the wetland resources themselves but the ability of the resources to respond to and mitigate negative impacts associated with natural events or human activities. As a resource- and science-based management approach that presumes each resource area is significant to one or more interests of the Act, the state coastal wetland regulations provide a sound framework upon which to implement a regional approach to shoreline management. While local zoning and flood plain management bylaws provide some similarities, these approaches tend to focus on the regulating *activities* along the shoreline as opposed to the wetland regulations that focus on resources. Based on the material developed in the

matrix, Table 1 summarizes the similarities and differences between local zoning and flood plain management along the eastern Bay shoreline.

LOCAL ZONING	Eastham	Wellfleet	Truro	Provincetown
Districts	residential marina	residential commercial	residential business	residential commercial
Minimum Lot Area Definition	Shall include only contiguous upland and exclude all wetland or land under any stream, creek, or other waterbody	Excluding land that is swamp, pond, bog, dry bog, marsh, areas of exposed groundwater, or below mean high tides	Shall not include any area below mean high water & $\geq$ 100% of the min. required lot area shall not include marsh, beach, or dune	Excluding any land which is under any waterbodies or marsh (as defined in MGL c.131, s.40)
Minimum Lot Area (SF)	40,000	20,000 - 40,000	33,750	5,000 - 16,000
LOCAL FLOODPLAIN ZONING	Eastham	Wellfleet	Truro	Provincetown
Use Regulations				
VE Zones	Alteration of sand dunes and salt marshes that would increase potential flood damage prohibited.		Alteration of sand dunes, which in the opinion of the Building Comm. may inc. potential flood damage, prohibited.	Must demonstrate that any alteration of sand dunes will not increase the potential for flood damage
	New construction must be located landward of the reach of mean high tide	New construction must be located landward of the reach of mean high tide.	New construction must be located landward of the reach of mean high tide.	Must demonstrate w/ ZBA Special Permit that development located landward of the reach of mean high tide

Table 1

As shown by Table 1, local zoning and floodplain zoning requirements focus on building conditions that specify building requirements (e.g., elevations above flood levels, construction specifications, etc.), development densities (e.g., setbacks and minimum lot areas), and allowable uses (e.g., residential, commercial, etc.). In contrast, the wetlands regulations focus not on the regulation and conditioning of human activities but rather on the protection of the benefits that wetland resources provide (e.g., their ability to prevent or minimize storm damage, mitigate flooding, etc.)

As depicted in the matrix, the towns of Eastham, Wellfleet, Truro, and Provincetown, have adopted wetland bylaws and regulations based generally on the Massachusetts Wetlands Protection Act and its implementing regulations (310 CMR 10.00). While the wetland bylaws and regulations mirror much of the state approach, there are significant differences from town to town in terms of jurisdiction, definitions, interests, and the way Buffer Zone activities are addressed. Table 2 summarizes these differences.

WETLANDS REGULATION				
MA Wetlands Regulations	Eastham	Wellfleet	Truro	Provincetown
INTERESTS/VALUES	ADDITIONAL LOCAL INTERESTS/VALUES			
public and private water supply	erosion control	erosion & sed. control	erosion & sed. control	groundwater quantity & <i>quality</i>
ground water supply	recreation	ground water <i>quality</i>	ground water <i>quality</i> & supply	erosion & sed. control
flood control	waters containing fisheries		rare species habitat	fisheries, shellfish
storm damage prevention	waters containing shellfish		aquaculture	rare species habitat, inc. plants
pollution prevention				agriculture
land containing shellfish				aquaculture
fisheries				recreation
wildlife habitat				
COASTAL RESOURCE AREAS	ADDITIONAL LOCAL COASTAL RESOURCE AREAS			
Land Under the Ocean	ACECs	Estuary	LSCSF	Estuaries
Coastal Beaches		ACEC		Designated NHESP Areas
Coastal Dunes		LSCSF		
Barrier Beaches				
Coastal Banks				
Salt Marshes				
Land Under Salt Ponds				
Land Containing Shellfish				
Anad./Catad. Fish Runs				
Est. Habitat of Rare Wildlife				
BUFFER ZONE				
Defined As:				
Area within 100 feet of any:	PLUS THE AREA WITHIN 100 FEET OF THE FOLLOWING LOCAL COASTAL RESOURCE AREAS			
Coastal Beach	Land Subject to Tidal Action	Estuary	Land Subject to Tidal Action	Estuary
Coastal Dune	Land Subject to Coastal Storm Flow	Land under Ocean		Ocean
Coastal Bank	ACEC Boundary			NHESP Boundary
Salt Marsh	Wildlife Refuge			
No Disturbance Zones				
None	May be required	50' for New Projects	50' min. for New Projects	50' No Disturb
	No Feasible Alternative	No Practicable Alternative	No Practicable Alternative	80' Setback for Prop. Structures
	No Significant Adverse Impacts			

Table 2

As illustrated by many of the data layers compiled for the database, the developed and natural shoreline conditions of eastern Cape Cod Bay from Eastham to Provincetown are relatively similar and uniform. With similar coastal resources connected by the same coastal processes, the management of this coastal system lends itself to a regional approach. Further, as a science-based approach to resource management that is familiar to the towns, the Massachusetts wetlands regulations, and associated local wetland regulations, provide a tested management framework from which to pursue implementation of such an approach. Recognizing that differences between interpretation and approach do exist currently between the towns, the project team concluded that future work is necessary to develop a uniform shoreline management approach or framework. Among the recommendations for further work, the team identified the following priority areas:

- Where possible, reconcile major differences identified between the Wetland Bylaws of each town in terms of jurisdiction, definitions, resource interests or values, and resource areas.
- Identify potential opportunities for regulating coastal resource area activities in a uniform manner.
- Explore the possibility of introducing a uniform variance process, with associated conditions, for activities unable to meet performance standards of local regulations
- Development of uniform, science-based management principles, policies, and guidelines.
- Development of project-based standardized Orders of Conditions, based on:
  - Uniform plan requirements.
  - Standard permit conditions based on project type and & location within management unit (e.g., source v. sink).
  - Uniform nourishment requirements
    - Volume calculations
    - Frequency
    - In-lieu payment
    - Compatibility (e.g., grain size, composition, etc.)
    - Time of year for placement

## Listening Sessions

Recognizing the complex nature of developing a regional shoreline management plan, major goals of Phase 1 have focused on developing an *Intermunicipal Shoreline Management Geodatabase* and producing an intermunicipal memorandum of agreement (MOA), signed by the four Select Boards, agreeing to continue to pursue a regional approach in subsequent phases. Coincident with these objectives, has been an effort to identify common management goals and challenges where cooperation between the four participating towns can be mutually beneficial, resulting in increased effectiveness and efficiencies, and the development of recommendations for Phase 2 objectives.

To obtain suggestions and input from local departments dealing with various shoreline issues, town staff from the four towns were invited to participate in one of two listening sessions hosted by the project team. Although it was originally envisioned that four small sessions would be held in each town, the project team felt that the regional nature of the project would benefit more from potential intermunicipal discussions that would be more likely to occur with two larger meetings. As a result, meetings were hosted at the Eastham Town Library from 1:00 – 3:00 PM on February 26, 2020 and at the Center for Coastal Studies from 10:00 – Noon on February 27, 2020. Open to the public at large the meetings were well attended by a variety of town staff including Conservation Commission agents, Board of Health agents, Town Planners, Beach Directors, Harbor Masters,



Emergency Planners, Department of Public Works Directors, Police and Fire Department representatives, Shellfish Officers, and Town Managers.

### *Identification of Intermunicipal Challenges and Opportunities*

Each listening session was facilitated by a former Massachusetts Assistant Secretary of Environmental Affairs/Coastal Zone Management Director with experience in moderating large policy discussions. As envisioned, information developed from the Shoreline Resource Database and the Regulatory Matrix was used to characterize similarities and dissimilarities between the regulatory and policy-based shoreline management approaches of the four outer Cape Cod Bay towns. This information was in turn used by the facilitators to frame and moderate session discussions with the goal of documenting the concerns, challenges, and suggestions of town staff regarding short- and long-term approaches to shoreline management. This input was subsequently used in the development of recommendations for an intermunicipal shoreline management framework summarized at the end of this report.

Copies of the Listening Session agenda, handouts, attendance sheets, and minutes can be found in Appendix C.

### *Results and Recommendations*

As demonstrated by the attendance lists contained in Appendix C, the Eastham and Provincetown listening sessions were well-attended by staff from all four participating towns indicative of the interest in a regional approach to shoreline management. After a brief overview of the project, participants engaged in lively discussions about current and future climate related challenges facing their departments and provided thoughtful recommendations about how Phase 2 of this project could assist them with developing effective and efficient management responses and strategies.

Despite the broad sweep of participant interests ranging from the protection of coastal resources to the maintenance and protection of infrastructure to protection of the health, safety and welfare of town residents, interests focused on the value of the *Intermunicipal Shoreline Management Geodatabase* and the types of geospatial data layers that it could provide. Reflective of their backgrounds, participants offered myriad suggestions of the types of information and data to help with the development of short- (e.g., emergency response) and long-term (capital planning) strategic responses to changing climatic conditions. Ranging from an inventory of low-lying roads and the mapping of local evacuation routes for police, fire, and public works departments to the mapping of sediment movement (e.g., erosion and accretion) along the shore for coastal managers, the value of accurate geospatial data was implicit in many of these suggestions. Resiliency-related data layers seemed to promote the most attention during the sessions and are listed in the summary at the end of this section.

In addition to a focus on additional feature data sets, discussion in both sessions clearly highlighted the need to provide geospatial information clearly in ways that are accessible and understandable by non-GIS users. As in project team discussions, the ability to interpret, visualize, and communicate complex scientific and physical data so that results are intuitive to the non-GIS user emerged as a common recommendation. Initial data sets developed by CCS to characterize resiliency and summarize data, were identified as an approach that should be pursued further. Finally, to reach a wider user audience and to facilitate broader use, both groups recommended that the geodatabase include provisions for the adding of downloadable, pre-formatted maps and images that reflect specific user group requests, requiring minimal GIS knowledge to access. Examples included an inventory of potential sources of nourishment material, a visual summary of alongshore erosion and accretion, maps depicting evacuation routes based on total water levels, vulnerable roadways and infrastructure organized by user group.

A third recommendation from the listening sessions identified a need for a broad public education and outreach effort describing the project goals and the benefits and results of a regional approach to shoreline management. Public education and outreach were viewed as important to: obtain continued project support and buy-in; foster intermunicipal cooperation among town residents; and promote the long-term project goals. In addition to public presentations to both year-round and summer residents, other outreach suggestions included the development of informational posters, brochures, and pamphlets for display at libraries, transfer stations, visitors' booths, and local businesses and targeted material for local groups such as Chambers of Commerce and Non-resident Taxpayer meetings.

The following list summarizes general Listening Session discussion topics and recommendations for Phase 2 work:

- In addition to interactive scientific and other technical data layers, the geodatabase should include companion data layers that interpret results and communicate findings using simplified visual characterizations requiring minimal GIS capabilities.
- The geodatabase should be organized around key user group feature datasets for example:
  - coastal resource managers dataset,
  - public safety dataset (police and fire),
  - public works dataset (infrastructure), and
  - beach managers dataset (open space and recreation).

The system should be expandable to include other user groups and uses in the future such as shellfish management(aquaculture), permit archiving (Orders of Condition, Chapter 91).

- The geodatabase should include preprinted materials (e.g., maps, tables) that are responsive to the requests of individual user groups.
- Data layers summarizing sediment management information such as nourishment requirements, potential sediment sources, and historical dredging should be developed

along with a method for the towns to update the information in a consistent and uniform manner.

- An inventory of low lying roadways and vulnerable infrastructure should be developed based on the county's storm tide mapping program. Working with emergency responders, pre-printed maps representing various coastal storm flooding conditions and evacuation routes should be developed for easy access.
- Education and outreach materials should be developed, including printed materials and presentations, to describe the project to the four outer Cape communities.

## **Intermunicipal Shoreline Management Geodatabase**

Based on the information compiled from the shoreline resource database, the regulatory matrix, and the listening sessions, an Intermunicipal Shoreline Management Geodatabase was finalized and data layers created to help inform recommendations for the development of a consistent, effective, and efficient four-town (regional) shoreline management approach in subsequent projects. In fact, the geodatabase has already yielded answers from inquiries by town staff during the project.

Proactive shoreline management requires a thorough understanding of local and regional coastal processes and human uses (Maine, 2017; Maine, 2006). Individually and together, the geospatial data layers compiled in the Shoreline Resource Database illustrate clearly that natural shorelines possess inherently resilient characteristics with an ability to respond to coastal hazards independently of municipal boundaries. With its inventory of human influences, this database further demonstrates that disturbances to natural coastal systems can significantly threaten coastal resilience. Highlighting this ageless conflict between natural systems and human activities, initial database observations suggest that regional, science-based management of coastal resources can result in an approach that more effectively and efficiently guides human use of the shoreline.

A key component of the *Intermunicipal Shoreline Management Geodatabase (ISMG)* consists of geospatial data layers describing contemporary shoreline resilience conditions throughout the study area to provide context for discussing the challenges currently confronting each town's management efforts. To develop these data layers, key characteristics of individual natural resource and human use geospatial data layers were used by CCS to communicate the potential long-term management challenges between often competing natural and human forces along the shoreline. Using the power of a comprehensive geodatabase, several geospatial resiliency characterizations were developed based on combining or overlaying multiple individual data layers to explore the benefits of a regional approach to resource and system management.

One important characterization developed for the geodatabase is the characterization of littoral cells within the planning area. This characterization was based on the work of several completed studies funded through the CZM Resiliency Grant Program quantifying sediment transport systems within the planning area (Borrelli et al., 2015; Borrelli et al., 2017; Giese et al., 2013, Giese et al., 2018). Littoral cells are natural units used to describe nearshore sediment transport systems and, as discussed below, provide an excellent spatial framework for a future approach to regional shoreline management.

In addition to the final MOA, the completed *ISMG* represents a fundamental component of Phase 1, and a primary source of recommendations for Phase 2 work, of a regional approach to shoreline management. Viewed as a living source of geospatial information necessary to define evolving coastal issues and formulate strategic responses, the Geodatabase can be further developed to incorporate emerging scientific data. Similarly, if managed effectively, the Geodatabase can serve as an up-to-date archive of shoreline management information such as nourishment locations and volumes, harbor dredging histories, storm tide pathway and vulnerable roadway locations, and coastal storm-based evacuation routes.

Perhaps most significantly, in the face of a changing climate presenting new and more severe management challenges, it is envisioned that the Geodatabase will form the basis for identifying and developing the future data needs and recommendations necessary for the continued implementation of a intermunicipal shoreline management framework.

Appendix D contains a summary of the feature datasets and incorporated data layers contained in the *Intermunicipal Shoreline Management Geodatabase*, including those characterizing scientific data developed specifically for the four towns' Cape Cod Bay shoreline. Currently, the geodatabase contains 62 data layers organized into 6 datasets and includes:

- Administrative Boundaries (3 feature classes)
- Human Use (12 feature classes)
- Coastal Resources (5 feature classes)
- Shorelines – Contemporary and Historic (5 feature classes)
- Center for Coastal Studies Shoreline Characterizations (16 feature classes)
- Regulated Areas – Federal, State and Local Management Considerations (21 feature classes)

Also included are 4 standalone rasters and 1 raster dataset of georeferenced dredge plans. Of the 67 total components, 32 were created by the Center for Coastal Studies (this includes those data layers reimagined from existing datasets).

### *Results and Recommendations*

In order to promote a proactive management approach, development of the management geodatabase was based on the concept that an understanding of the science associated with local and regional coastal processes, and the ability to visualize and communicate it clearly, is a fundamental component of a resource-based approach to shoreline management. As a result, the management geodatabase was developed to be a living, unbiased source of high quality, multi-discipline information based on the following guiding principles:

- There is an inherent conflict between natural, energetic, coastal processes that provide long-term resiliency by continuously adapting to a changing environment and many traditional human activities along the shore that when threatened by changing conditions look to implement solutions designed to confront natural responses and promote permanency.
- Confronted by goals for static solutions within a dynamic environment, the ability to manage shorelines is further complicated when implemented in response to municipal boundaries rather than those of natural systems.
- Since the solutions to many coastal resource management challenges are encountered first at the local level and not constrained by artificial boundaries, the geodatabase should support an approach that is independent of municipal boundaries, grounded in multi-discipline science, and considers human uses in the context of ongoing coastal processes and systems.
- In addition to scientific data, the geodatabase should include data layers developed to visualize and communicate the results of high-quality, system-based scientific information simply and clearly to coastal managers and other interested groups.

Project team discussions, listening session comments with town staff, and webinar recommendations recognized the importance of reliable, contemporary, science and applied science information to the implementation of an effective regional approach to shoreline management approach. As the fundamental component for information management, recommendations to build upon the *Intermunicipal Shoreline Management Geodatabase* highlighted the need for data sets that visualize and communicate scientific data clearly. Comments generally focused on future uses of the Geodatabase, suggestions for design features such as uniform record updating (e.g., nourishment activities), suggestions for Phase 2 data layers, and input on potential database uses. General recommendations for the completion of the management database in Phase 2 are summarized by the following:

- Development of additional data layers that communicate the results of science and coastal process-based data simply and visually for use in the development of shoreline management strategies.
- Create user specific data products (as requested by town staff) including additional feature datasets, shapefiles, and standalone maps.

- Standardize and simplify data input process and archiving systems with a focus on keeping data current.
- Create workflow that allows towns to update the geodatabase with new information, retrieve archived information, and interact with data layers.

#### **Four (4) Town Memorandum of Agreement (MOA)**

As another centerpiece of this Phase 1 work with input from the members of the project team, an MOA entitled, *Memorandum Of Agreement between the Towns of Provincetown, Truro, Wellfleet, and Eastham to pursue the development of an Intermunicipal Shoreline Management Plan* was approved by each town's Select Boards. In general, the MOA sets forth each town's desire and commitment to continue pursuing the implementation of an intermunicipal shoreline management framework to be developed in future phases of this project.

Specifically, the MOA signifies the towns' intent to continue to:

- Develop and provide an accurate, up-to-date Intermunicipal Shoreline Management Database.
- Pursue the development and implementation of an Intermunicipal Shoreline Management Framework that promotes a science-based approach for the management of the shoreline of Eastern Cape Cod Bay; and
- Work together in pursuit of the common goal of improving long-term coastal resiliency through the development and implementation of uniform policies and regulations that promote common management principles and responsible stewardship relative to wetland resources, wildlife, fisheries, boating, shorelines structures, and public access along this shoreline.

A copy of the approved MOA, signed by the Truro Select Board is contained in Appendix A. Note: Due to unforeseen scheduling issues associated with the pandemic, review of the MOA by town counsels for the Eastham, Wellfleet, and Provincetown Select Boards was delayed and a copy of the final MOA, signed by each Select Board, was not available by the end of this grant. It is anticipated that all signatures will be obtained by mid-July at upcoming Select Board meetings.

#### **Project Communication and Meetings**

The initial Scoping Meeting for the project was held by the Massachusetts Office of Coastal Management on September 18, 2019 with representatives of the towns of Wellfleet, Provincetown, Truro, and Eastham, and the Center for Coastal Studies and the final contract executed on October 24, 2019. Recognizing the goal of the four towns represented the first concerted effort in the Commonwealth to develop a regional approach to shoreline management, the participants agreed, in the absence of a blueprint describing the process, the project would benefit greatly from an

intentional and frequent project communications. Acknowledging the value of expanded communications and the shortened grant time frame, CCS agreed to incorporate the following work into its project scope:

- Attendance at a minimum of one project team meeting per month to discuss tasks and next steps.
- Development of a presentation describing the scope of work and project goals for a meeting and discussion with the Town Managers of each town on October 23, 2019.
- Development of presentations for each town Select Board describing the scope of work, grant goals and objectives, and the MOA for presentation at regularly scheduled meetings, televised on local cable TV

In March 2020, and in response to the Governor's Executive Orders calling for temporary business closures and a limitation on gatherings, the project team requested that two (2) webinars be substituted for the end of project public meeting. CCS agreed to lead the webinars developing one to present the geodatabase to town staff and obtain recommendations for the development of additional data layers and a second webinar to present the project to the public. The goal of these meetings was to obtain input for Phase 2 of the project, particularly from town staff relative to additional data layers for the *Intermunicipal Shoreline Management Geodatabase*. Where possible, many of these comments were incorporated into the proposed scope in the upcoming CZM Resiliency Grant application for Phase 2. The webinars were recorded and made available for public viewing through town websites.

## **Intermunicipal Shoreline Management Framework**

To achieve the objectives of Tasks 1-5 of the grant proposal, a draft Intermunicipal shoreline management framework was developed and grounded in an intermunicipal agreement for a science-based approach to manage shoreline processes and coastal resources regionally to promote increased resiliency in response to a changing climate. This framework was used to organize the project and to develop recommendations that inform a final approach upon which a more consistent, effective, and efficient four-town shoreline management approach can be implemented in a subsequent project. In general, the draft intermunicipal management framework reflects the goals of the four participating towns to manage their Bay shoreline based on a common set of scientifically-based principles, guidelines, and policies that promote the benefits of a system-wide approach and result in a more resilient shoreline that is responsive to rising sea levels, intense coastal storms and a changing climate.

Although subject to future refinement in Phase 2, it was envisioned that the intermunicipal framework will initially consist of a set of consistent science-based management principles and standard project conditions that can be implemented uniformly and expeditiously by each town within the planning area. In this way initial benefits of a regional approach could be used to support

on-going work within the towns such as the Wellfleet Conservation office project to revise its Conservation bylaw to address climate change. Further, the longer term results of a regional approach could be advanced with recommendations for potential local bylaw and regulatory changes pursued in the future in accordance with the provisions of the MOA, if warranted.

#### *Draft Intermunicipal Shoreline Management Framework*

A draft *Intermunicipal Shoreline Management Framework (ISMF)* was prepared to pursue the long-term goal of developing a regional shoreline management approach for the eastern shoreline of Cape Cod Bay. This draft framework was used to identify potential data sets for the Shoreline Resource Database, organize team discussions, develop presentations to town managers and Select Boards, and facilitate listening sessions with town staff for the purpose of obtaining suggestions and feedback for the Phase 2 approach.

The draft ISMF approach was organized spatially around the concept of littoral cells. Littoral cells describe coastal compartments that contain a complete cycle of sedimentation including sources, transport paths, and sinks. Cell boundaries delineate the geographical area within which the sediment budget is balanced, providing the framework for the quantitative analysis of coastal erosion and accretion. (See Berman, 2011, for full discussion). Littoral cell boundaries do not align with municipal boundaries and frequently encompass multiple towns.

To visualize this approach, data layers were developed for the management geodatabase characterizing the sediment transport system along the eastern shoreline of Cape Cod Bay. Based on the work of several completed studies funded through the CZM Resiliency Grant Program quantifying sediment transport systems within the planning area (Borrelli et al., 2015; Borrelli et al., 2017; Giese et al., 2013, Giese et al., 2018), these data layers depict generally the location of littoral cell boundaries, the direction of net sediment movement, nearshore areas of erosion and accretion, and the location of sediment sources and sinks within the planning area. These units were used to describe net sediment transport (direction and volumes) along the shoreline planning area are depicted generally on Figure 2. Significantly, because they do not respect municipal boundaries, the natural boundaries of littoral cell systems can be used to facilitate a regional, resource-based approach to shoreline management.



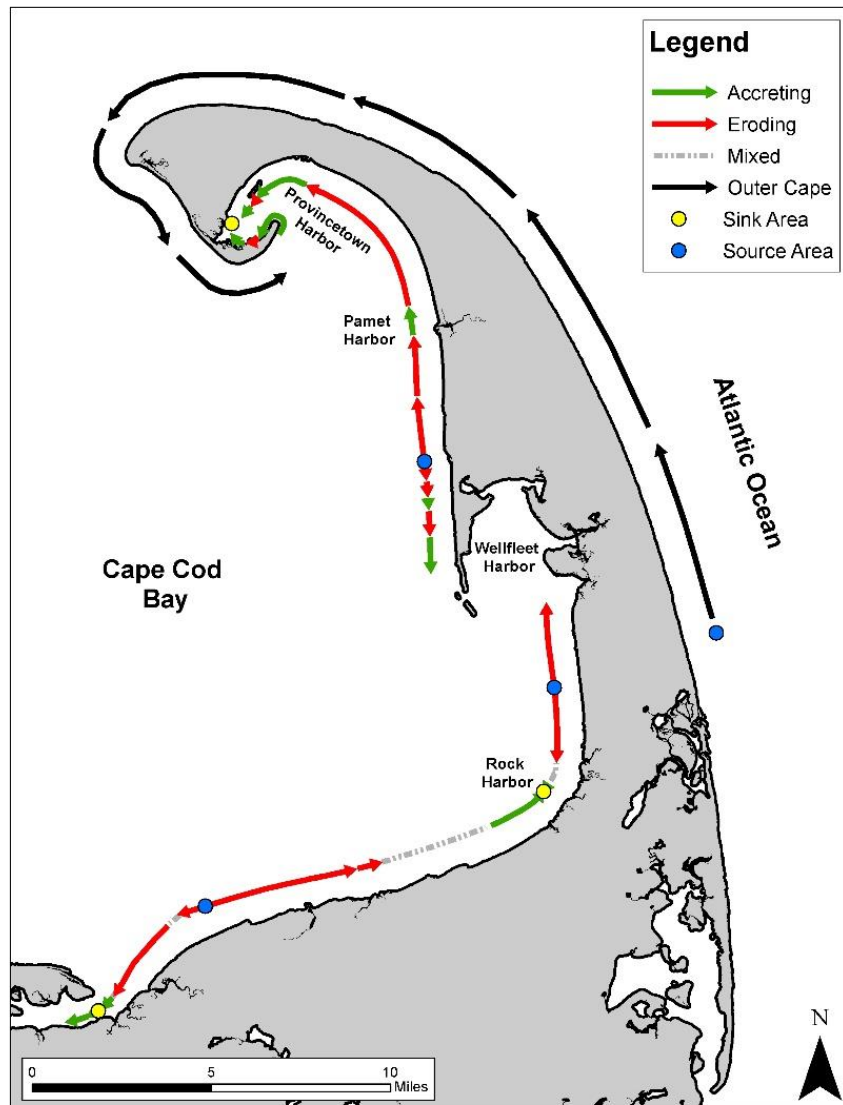


Figure 2: Generalized View of Outer Cape Net Sediment Transport System

During the project there was unanimity among town staff from the project team that the use of littoral cells as the spatial framework for a regional shoreline management approach should be pursued in greater detail in Phase 2. More specifically, based on the scientific data compiled as part of the Shoreline Resource Database, the further refinement of littoral cells into smaller management cells or units based on areas of erosion and accretion, proximity to sediment sources and sinks, physical shoreline characteristics (e.g., type of resource, presence of engineering structures, development densities, etc.), etc. may prove more effective in terms of increasing coastal resilience. This approach was strongly suggested as the foundation upon which a regional approach to shoreline management should be built upon.

The draft ISMF developed for Phase 1 consists of the following principles:

- In recognition of the long-term nature of the work, develop a MOA between the towns of Eastham, Wellfleet, Truro, and Provincetown agreeing to continue to pursue the difficult and complex goals of a regional approach to shoreline management.
- The goal of the ISMF is to increase shoreline resiliency through a science-based approach that is grounded in proactive regional management of shoreline resources and systems in the context of traditional approaches that regulate individual shoreline activities.
- As a regional approach, the natural boundaries associated with littoral cells established through sediment transport calculations should provide the spatial approach to intermunicipal shoreline management, rather than town boundary lines.
- Management information will be provided through an Intermunicipal Shoreline Management Database that makes high-quality, temporally relevant scientific information on coastal processes and coastal resources available to town staff.
- Common to all four towns, the Wetlands Protection Act, and its implementing regulations (310 CMR 10.00) and principles provide an initial regulatory framework for a regional approach. Where possible, local wetland bylaws and regulations should be reconciled in terms of jurisdiction, definitions, and interests.
- Initial implementation of regional shoreline approach to be pursued through the development and local adoption of:
  - Uniform resiliency-based management principles, policies, and guidelines
  - Standard set(s) of project-specific requirements and conditions

In addition to communicating initial project goals and objectives, the draft ISMF was envisioned as a way to promote project team ideas and to elicit suggestions and recommendations from town staff to inform further efforts to pursue a four-town approach to regional shoreline management in a subsequent project. Earlier sections of this report summarize these recommendations. Based on team meeting discussions, the recommendations were organized into six major categories and prioritized. Although many interesting ideas were presented at the listening sessions, recommendations that related directly to the draft *ISMF* and the resiliency goals of CZM's grant program were a high priority of the project team. Further, the project team concluded that, while worthy of further pursuit, efforts to pursue support for some of the suggestions might be more successful through other funding mechanisms. Based on its work to date, the project team organized its recommendations for next steps into six major categories summarized below.

#### *Recommendations for next steps*

##### **1. Complete Development of the Intermunicipal Shoreline Management Geodatabase**

The development of an up-to-date, intermunicipal, science-based geodatabase is a fundamental component of the four-town regional management approach. In addition to the development of new, user requested data, the need for visualizing and communicating scientific results clearly and simply for use by local managers was also identified. Specific

recommendations for the completion of the management geodatabase include the following:

- Create data layers that visualize and communicate the results of complex scientific data so that it can inform regional management strategies.
- Develop simple workflows that allow towns to update and access database.
- Standardize and simplify methods for data input, archiving and retrieval to ensure database records are current and provide relevant information. Examples include:
  - Nourishment and dredging records
  - New and modified coastal engineering structures
  - Coastal storm inundation records and storm tide pathway activation
- Create new data products (feature classes, shapefiles, and standalone maps) that address specific management issues identified by the four town staff Examples include:
  - Identification of storm-related neighborhood level evacuation routes
  - Inventory of low-lying roads, including identification of vulnerabilities, potential design solutions, and approximate cost estimates
  - Inventory of potential upland nourishment sources (e.g., exist gravel pits) with potential volumes and estimate of life expectancy
  - Sediment Transport/Littoral Cell/Management Units
  - CCS Storm Tide Pathway (STP) information
  - Inventory of potential upland sand banking or stockpiling sites
  - Visualization of coastal change through time using historical aerial photos to show changes in the landscape
  - Inventory of potential open space parcels for acquisition that are frequently flooded or could potentially accommodate salt marsh migration.

## **2. Develop and Implement Components identified in draft Intermunicipal Shoreline Management Framework**

As discussed in the previous section, the draft Intermunicipal Shoreline Management Framework identified six (6) key components for developing a regional management approach for the eastern shoreline of Cape Cod Bay. Several of these objectives have been largely achieved in this phase of the project including: 1) formalizing an MOA between the four towns to continue to pursue a regional approach; 2) articulating an overarching project goal to increase shoreline resiliency through an intermunicipal, science-based approach to shoreline management; 3) the use of littoral cell boundaries in lieu of town lines to define the spatial framework for a regional management approach; and 4) general agreement to use the provisions of the current Wetlands Protection Act and its implementing regulations as the regulatory basis for regional management efforts. Based on the preliminary development of the Intermunicipal Shoreline Management Database as described in the project scope, final recommendations for its completion are discussed

above. Recommendations for further developing the framework include refining the existing regulatory framework to include following approaches for local adoption and implementation:

- Using the results of existing studies, accurately map littoral cell boundaries based on sediment budget calculations and further subdivide the cells into management units based on shoreline characteristics such as extent of shoreline armoring, levels of erosion or accretion, types of coastal resources, proximity to sediment sources and sinks, development density, flooding potential, etc.
- Using the Regulatory Matrix as a guide, identify local wetland bylaw conflicts and incongruities with regulatory jurisdiction, definitions, interests, and proposing variance processes where possible.
- Develop uniform resiliency-based management principles, policies, and guidelines to guide the design and review of activities in the planning area
- Develop uniform plan requirements for activities proposed for the planning area
- Develop standard set(s) of project-specific requirements and conditions based on the type of activity and management cell location to be issued with Orders of Conditions, including:
  - Uniform requirements for beach nourishment specific to each littoral cell
  - Uniform monitoring requirements

### **3. Develop a Potential Regional Sand Banking System for Town Implementation**

According to data culled from the Intermunicipal Shoreline Management Geodatabase, based on information provided by the towns approximately 25,000 to 35,000 cubic yards of upland sand is placed along the eastern shoreline of Cape Cod Bay annually to satisfy requirements set forth in Orders of Conditions and other permits. With this amount increasing, anecdotal evidence offered by members of the project team indicated that the availability of suitable nourishment material may at some point soon become a concern.

Coincidentally, towards the end of this phase of the project, the team noted that a project occurring in one of the towns required the removal of a large volume of material, of which at least some was presumed to be suitable for beach nourishment. Recognizing sand is an increasingly scarce resource, the team explored ways to reserve the material, however, the lack of an administrative process, pre-established stockpile sites, and soil testing requirements in the context of the state-wide shut down made it impossible to finalize conditions. This experience coupled with estimates of annual nourishment requirements lead the team to recommend that in addition to an inventory of existing upland sources of nourishment material, the next phase of the project look to develop a system where sand excavated from a variety of projects could be stockpiled to help meet future nourishment requirements. Further, it highlights the potential strengths of intermunicipal shoreline

management by including the needs of all four towns when making decisions rather than a single municipality.

In addition to developing data layers of existing upland sources and potential banking sites, specific recommendations for the development of a regional sand banking system include the following:

- Quantifying current and projected annual nourishment requirements from updated town records and assessment of potential for coastal engineering structures.
- Identifying potential sources nourishment material with estimates of present/future volumes (longevity) and
- Identifying potential sources of nourishment material (generally) such as excess material from construction sites, road construction, etc.
- Identifying potential upland banking sites for upland sand banking
- Identifying potential sites for stockpiling suitable dredge materials
- Explore potential administrative approaches and implementation mechanisms, for example:
  - i. Intermunicipal agreements
  - ii. earth removal bylaws
  - iii. other incentive mechanisms for construction activities

#### **4. Identify and assess parcels for potential salt marsh migration**

A review of the data layers contained in the ISMG indicates that the project planning area contains approximately 2,405 acres of salt marsh as of 2005, the most up to date DEP salt marsh layer for the planning area. In the face of changing climate conditions, there is increasing concern that many ecologically valuable salts marshes are constrained by their physical environments and unable to migrate landward in response to rising sea levels. Lacking an ability to respond, the long-term sustainability of many salt marshes is endangered jeopardizing coastal water quality and habitat and reducing natural shoreline resiliency and other co- benefits. Recognizing that salt marsh loss is an ongoing and important shoreline management consideration, it was recommended that additional data layers be added to the ISMG to identify potential parcels in the planning area that may have conditions suitable to accommodate salt marsh migration. Specifically, this recommendation will focus on the following:

- Using 2019 aerial photographs and parcel, resource area, and elevation data contained in the Shoreline Resource Database an initial screening of salt marsh in the planning area will be performed to update salt marsh extents, and identify parcels potentially capable of supporting salt marsh growth and migration.
- Next, potential areas where salt marsh ecosystems could migrate into within the study area will further be reviewed based, in part, on criteria developed by the MA Office of Coastal Zone Management (e.g. tidal inundation/restrictions,

sedimentation rates-vertical growth, erosion/accretion rates, ‘accommodation space’, slope), where those data are available or attainable within the project budget, timeline and scope.

- Finally, working with town staff and staff from Cape Cod National Seashore a final prioritized list of potential locations will be developed.
- At the conclusion of the assessment, geospatial data layers showing the location of suitable parcels will be provided to municipal open space committees and local land trusts for incorporation into town/trust open space acquisition plans.

## **5. Create an inventory of low-lying roadways and related infrastructure**

A common suggestion that emerged from the listening sessions was the need to develop a simple inventory of low-lying roadways and related infrastructure for each town. Interests focused on the inundation associated with both historical storms of record and the recent flooding events of 2018. Familiar with CCS’s ongoing project to map storm tide pathways along Cape Cod Bay shores, town staff were interested in the potential for using these data to identify the critical flooding elevations of low lying roads and prioritize potential capital improvements based on the threats posed by the flooding, the viability of potential design solutions, and estimated costs. In addition, it was hoped that this information could be organized to provide short term emergency response strategies related to road closures and neighborhood evacuation routes. Specifically, this recommendation will focus on the following:

- Completed and ongoing CCS Storm Tide Pathway mapping efforts will be used to identify and inventory vulnerable low-lying roads and associated infrastructure.
- Based on this inventory, vulnerable areas and roads will be assessed under various storm flooding conditions.
- Potential design solutions will be prioritized based on the level of impacts an estimate of approximate construction costs.
- The results of the storm tide mapping will also be used to work with police, fire and DPWs to develop short-term planning measures, coastal storm responses, and potential area specific evacuation routes.
- As requested by town staff, geospatial data layers and pre-packaged map products will be incorporated into the geodatabase to provide, where appropriate.

## **6. Education and Outreach**

Throughout the course of the project, project team members and listening session participants suggested consistently that innovative education and outreach programs would greatly aid in the advancement of the goals and objectives of a regional science-based approach to shoreline management. To communicate this new mindset, looking at new ecosystem-based management strategies as opposed to traditional geopolitical approaches requires not only educating coastal managers but reaching out to the public across a wide

spectrum of ages to improve the chances of implementing an intermunicipal approach. For this reason, in addition to the traditional end-of-project presentation of results in a public forum, an additional emphasis on education and outreach should be placed on communicating the technical aspects of phase 2, perhaps in the form of seminars for interested town staff, shorefront property owners, the general public and middle school students.

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## **Appendices**

### **Appendix A – Memorandum of Agreement (MOA)**

## **Appendix B – Regulatory Matrix**

**Appendix C** – Listening Sessions: Handout, Agenda  
Attendance Sheets, and Minutes

## Appendix D – Intermunicipal Shoreline Management Geodatabase (ISMG)

### Screenshot of Feature Datasets and Incorporated Data Layers

DATASET	FEATURE CLASS	DESCRIPTIVE TITLE
Administrative Boundaries	Assessor_Information_2019	Tax Parcels (2019) for Provincetown, Truro, Wellfleet and Eastham
	Orleans_TownLine_2019	Orleans Town Line
	ProjectExtent	Project Extent
Center for Coastal Studies Shoreline Characterizations	CCS_Approximate_Landward_Tideland_Jurisdiction	Approximate Landward Tideland Jurisdiction - 2014 Update
	CCS_Approximate_Private_Tidelands_Limit	Approximate Private Tidelands Limit Based on Chapter 470 of the Acts of 1893
	CCS_Approximate_Seaward_Limit_Private_Tidelands	Approximate Seaward Limit of Private Tidelands Pursuant to Chapter 91 and the Waterways Regulations
	CCS_ErosionDeposition_1933_2010	Century-Scale Bathymetric Change in Cape Cod Bay
	CCS_LittoralCells	Littoral Cells and the Sediment Transport System Along the Eastern Shoreline of Cape Cod Bay
	CCS_LittoralCells_NullPoints	Littoral Cell Null Points and the Sediment Transport System Along the Eastern Shoreline of Cape Cod Bay
	CCS_NetSedimentTransport	Net Sediment Transport Along the Eastern Shoreline of Cape Cod Bay
	CCS_StromTidePathways	Storm Tide Pathways (Inundation Pathways) for the Towns of Provincetown and Truro
	CCS_StromTidePathways_ConcentrationAreas	Storm Tide Pathways - Concentration Areas
	CCS_StromTidePathways_FloodStage_Concentrations	Storm Tide Pathways - Flood Stage Concentrations
	Estimated_HarborSedimentationRates	Estimated Annual Harbor Sedimentation Rates for Areas Routinely Dredged
	FloodHazards_SWEL	Stillwater Elevations for Cape Cod Bay Flood Events - Provincetown, Truro, Wellfleet and Eastham
	ManagementConsiderations_Overlay	Management Considerations - Federal, State, and Local Overlay
	Shoreline_BeachNourishment	Beach Nourishment Inventory for Truro, Wellfleet and Eastham (Shoreline Representation)
	ShorelineChange_LongTermRates	Shoreline Change Long Term Rates
Human Use	ShorelineChange_ShortTermRates	Shoreline Change Short Term Rates
	BeachNourishment	Beach Nourishment Inventory for Truro, Wellfleet and Eastham (Points)
	DredgeLocations	Dredge Project Locations - Provincetown Harbor, Pamet Harbor, Wellfleet Harbor and Rock Harbor
	Marinas	Sites of marinas, yacht clubs, and boat yards along the Massachusetts coast, 2019
	MarineBeaches_Public	Marine Beaches (Boundary Points)
	MORIS_CSI_PRIVATE_ARCLine	Private Shoreline Stabilization Structures in Massachusetts, 2013
	MORIS_CSI_PUBLIC_ARCLine	Coastal Infrastructure Inventory and Assessment Project Massachusetts Department of Conservation and Recreation Office of Waterways
	OFBA_BoatRamps	Office of Fishing and Boating Access Sites
	OpenSpace_2019	Protected and Recreational OpenSpace (Polygons)
	Pre1978_CoastalBankDevelopment	Coastal Bank Development Pursuant to the Wetlands Protection Act
Coastal Resources	Roads	2010 U.S. Census TIGER Roads
	Structures	Building Structures (2-D, from Ortho Imagery)
	Updated_CoastalStructures_2020	Updated Shoreline Stabilization Structures (2020) – Eastern Cape Cod Bay
	AnadromousFish	Anadromous Fish
	DesignatedShellfishGrowingAreas	Designated Shellfish Growing Areas
	EelgrassDEP	MassDEP Eelgrass (2015-2017)
	ShellfishSuitability	Shellfish Suitability Areas
Regulated Areas – Federal, State and Local Management Considerations	WetlandsDEP	MassDEP Wetland Polygons
	ACECS	Areas of Critical Environmental Concern
	Approximate_USACE_404Program	Areas Subject to USACE Discharge Regulations Pursuant to Section 404 of The Clean Water Act
	CACO	Cape Cod National Seashore Boundary Data
	CapeCod_OceanManagementPlan_Area	Cape Cod Ocean Management Plan Area
	CBRS	Coastal Barrier Resource Units
	CoastalRiver_Mouths	Coastal River Mouths
	FloodPlainZones	FEMA National Flood Hazard Layer
	LIMWA	Limit of Moderate Wave Action (LiMWA)
	Local_FloodPlainZones	Local Floodplain Zones (Extracted from the National Flood Hazard Layer Database)
	LocalZoning	Local Zoning
	MHC_Areas	MHC Historic Inventory (Areas)
	MHC_Points	MHC Historic Inventory (Points)
	MPAL_2017	NOAA's Marine Protected Areas Inventory (v2017)
	NHESP_ESTHAB	NHESP Estimated Habitats of Rare Wildlife
	NHESP_PRIHAB	NHESP Priority Habitats of Rare Species
	OceanManagementPlan_Area	Massachusetts Ocean Management Planning Area
	OceanSanctuariesAct	Ocean Sanctuaries
	ProvincetownHarborPlanningArea	Provincetown Harbor Planning Area
	StateDesignatedBarrierBeaches	State Designated Barrier Beaches
Contemporary and Historic Shorelines	T401_WaterQualityCertification	Approximate 401 Water Quality Certification Boundaries
	TidelandsJurisdiction_Ch91	Presumptive Tidelands Jurisdiction (Chapter 91) for the Commonwealth of Massachusetts
	CapeCodBay_NB_LT_Rates	Long-term shoreline change rates for the Cape Cod Bay coastal region in Massachusetts calculated with and without the proxy-datum bias using the Digital Shoreline Analysis System version 5.0
	CapeCodBay_NB_ST_Rates	Short-term shoreline change rates for the Cape Cod Bay coastal region in Massachusetts calculated with and without the proxy-datum bias using the Digital Shoreline Analysis System version 5.0
	CCS_Shorelines_2014	Tidal Shorelines Eastham to Provincetown, 2014
Rasters	USGS_CapeCodBay_Shoreline_2014	2014 profile-derived mean high water shorelines of Cape Cod Bay, MA used in shoreline change analysis
	USGS_CapeCodBay_Shorelines_1848_2009	Shorelines used to calculate shoreline change statistics from Cape Cod Bay coastal region
	Dredge_Plans	Dredge Plans Raster Dataset
	NewEngland_CMGP_SandyLidar_2013_2014	New England CMGP Sandy Lidar
	USACE_TopobathyLidar_2010	National Coastal Mapping Program Bare Earth Rasterized Topographic and Bathymetric Lidar Elevations
	USGS_ColorOrthoImagery_2014	2014 USGS Color Ortho Mosaic
	USGS_TopoQuad_Mosaic	USGS Topographic Quadrangle Mosaic